LESSON 5 – PRINCIPLES OF BASIC FIGHTER MANEUVERS (BFM)

Now that you know how to use the physics of flight to do some calculations, let's see how it's actually employed during basic fighter maneuvers (BFM).

Reading:

Shaw **pp. 62-74, pp. 15-30**

11-F16 **Sec 4.1 (p. 36), 4.6-4.6.7(pp. 39-60)**, 4.14-4.14.2 (p. 110), 4.14.4 (pp. 115-116), 4.14.6 (pp. 118-119)

Bretana pp. 71-80

Problems/Questions:

Work on Problem Set 1

Objectives:

5-1 Understand the three factors: range, aspect angle, and angle off (heading crossing angle), and how they relate to positional advantage.
5-2 Know the three types of pursuit curves and how they are used.
5-3 Understand what a High Yo-Yo is and when to use it during an aerial engagement.
5-4 Understand what a Low Yo-Yo is and when to use it during an aerial engagement.
5-5 Understand what a Lag roll is and when to use it during an aerial engagement.
5-6 Know the definition of a Weapons Employment Zone (WEZ).
5-7 Know the three requirements for a stabilized guns track.

Last Time: Energy Maneuvering
- Mechanical energy
- Total energy
- Specific excess power

Today:
- Pursuit Types
- Strategies
- Maneuvers
  - Lag Roll
  - High Yo-Yo
  - Low Yo-Yo

Equations: $r \propto V^2/G_r$, $\omega \propto G_r/V$, $P_s = (T-D)V/W$

Show 2" scale jets hidden in room doing HABFM – point out size and scale of room, size of typical fight, etc.

Get two cadets to stand up. Make one an attacker and one a defender, then tell them to chase each other around like they did when they were kids (do it in slow motion so they don't kill each other or fall down).

They should do the usual zig-zag weave thing.

Tell them that the weaving works in 2 dimensional chases, but not in three dimensional ones. More on this later…

Now, tell them to think about what difference it would be if they a really slick floor and one of them was wearing leather soled shoes and the other was wearing tennis shoes. Who would win? The one who could maneuver the best => the one who could pull the most Gs.

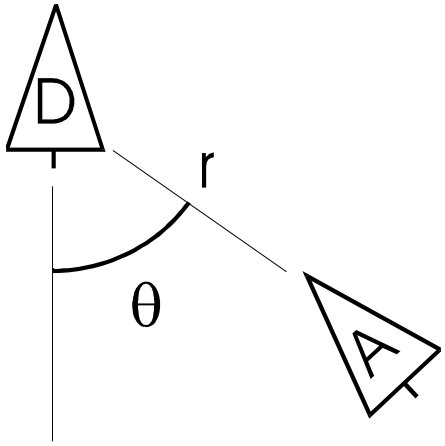
Now, tell them to think about running vs. walking and its effect on rate and radius of turn, which type of shoes will give the best performance?

All of this is a lead in to BFM—Basic Fighter Maneuvers.

The whole point of BFM is to maneuver your jet to get into/out of weapons parameters.

BFM is taught using the restriction that the attacker only has a gun and rear aspect boresight missiles only. In reality, other, more capable weapons are common but they are easier to use. If you can kill with these primitive weapons, you'll be capable of employing more sophisticated ones as well.

Weapons really like to use polar coordinates.



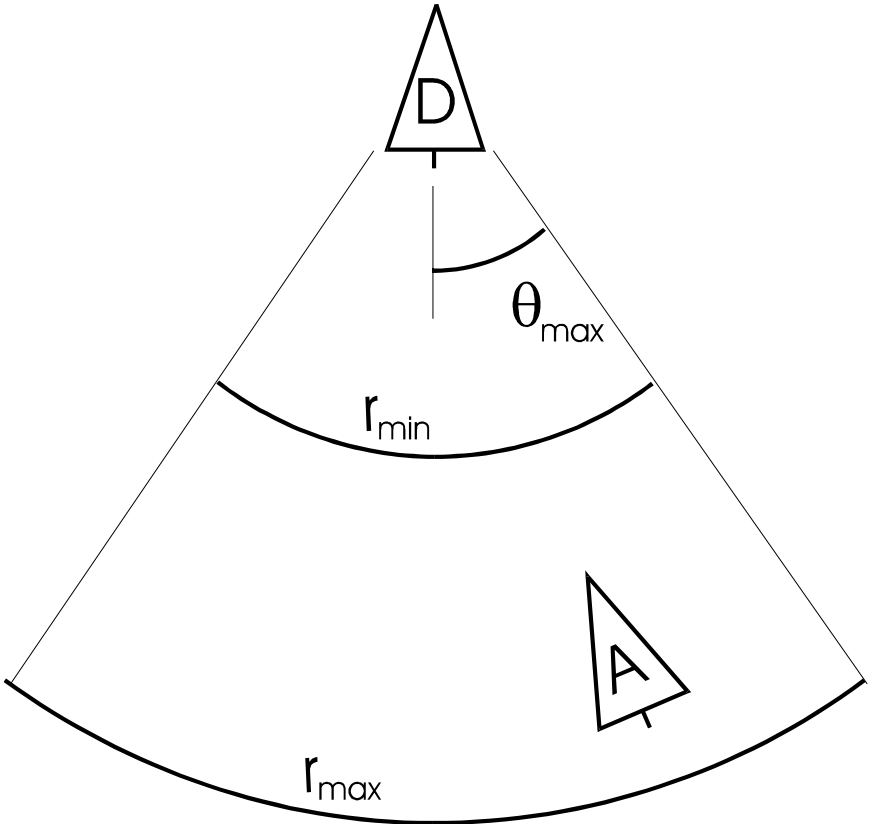
Notice that θ is measured FROM THE TAIL OF THE DEFENDER. This is called the aspect angle.

Also *note that that scumbag squid Shaw measures his aspect angle from the NOSE of the defender* (standard squid terminology). What we call aspect angle, he calls angle off tail (AOT)

To shoot any weapon, one must first satisfy both range and angle requirements, plus some others.

These parameters vary by weapon type. For the gun, the attacker's nose must be in lead and he has to be inside the max range. There is no min range for the gun (other than so close that you worry about fragging yourself).

For the boresight rear aspect missile, the attacker's nose must be pointed directly at the defender, he has to be inside the max range, and must be outside the min range. He also must be within a certain, specified aspect angle so the missile can see the defender's exhaust well enough to guide.



So, what should you do as a defender if you see an attacker in a threatening position? You have two options: run or turn.

IF YOU ARE:	Out of range - or - Faster…	In range - or - Slower - or - A shot is in the air…
You should:	RUN	TURN
Why:	Defeat range requirement	Defeat angle requirement
Sacrifice:	Angles	Range
Considerations:	"Ifs" hard to judge	Lose energy relative to the attacker if you maximize turn performance

Running either spoils the shot or it doesn't. If it doesn't, the defender is a mort. It's a pretty big gamble!

However, turning anchors you in one part of the sky and pretty much lets the attacker decide whether to fight or separate. Turning gives the attacker three options for pursuit: lead, lag, or pure.

Lead pursuit means the attacker's nose is ahead of the defender's position, or in a high-G fight, his lift vector is pointed ahead of the defender's position.

Lag pursuit means the attacker's nose/lift vector is behind the defender's position.

Pure pursuit means the attacker's nose remains directly on the defender.

Each of these pursuit types has a different combination of effects on the attacker's range and aspect angle. Discuss each in terms of different combinations of attacker/defender speed advantages.

Show the video of the FW190 vs. The P-47 (X:XX into the tape) showing how the FW uses lead and lag pursuit to effect a guns kill over the course of several turns. Also show the FW190 double-spin-to-a-Mustang-face-kill trick (X:XX) for grins.

So far, we've just discussed 2 dimensional pursuit curves and their effects. Let's look at 3-D maneuvers that are combinations of these basic pursuit curves. 3-D maneuvering also means we'll get to employ some energy concepts at the same time.

Demo the following with sticks and discuss pursuit curves and energy effects of the following basic low-aspect maneuvers:

High Yo-Yo – reduces aspect, increases range

Low Yo-Yo – reduces range, increases aspect

Lag roll – kills excessive closure

Questions?